

Acknowledgements

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Abstract

In this study, the linear analysis of stadia dome roofs using the finite element method was carried out considering the joints to be pinned, semi-rigid, or rigid. The straight space frame finite element was selected to represent the roof and the formulation of element stiffness matrix and nodal load vector in space was carried. SAP2000-16 Structural Analysis program was used to analyze and design five types of roofs. These were Flat roof, Ascending roof towards the field, Curved roof, Circular arc roof, and Circular dome roof. The results obtained for pin-jointed frames neglecting self-weight were compared with published results. The comparison shows good agreement with high accuracy not less than 99.66%.

The results of the analysis and the design after adding the self weight of the dome were obtained for pinned, semi-rigid, and rigid joints. These results were analyzed and compared with each other considering the dome fitness for purpose as the major factor. This was done with the aim of studying the effect of joint type on the dome performance. The comparison shows that semi-rigid joints give better results compared with pinned and rigid joints.

مستخلص

في هذه الدراسة تم إجراء التحليل الخطي لسقوفات قباب الملاعب باستخدام طريقة العنصر المحدد بإعتبار الوصلات إما مفصلية أو شبه صلبة أو صلبة. تم استخدام العنصر المحدد الفراغي الإطاري المستقيم لنمذجة السقف ثم اشتقاق مصفوفة الجساءة ومتجهة احمال العقد للعنصر في المستوي الفراغي. تم استخدام برنامج التحليل الإنشائي SAP2000-16 لتحليل وتصميم خمسة أنواع للسقوفات، هي السقف المسطح، والسقف الصاعد لأعلي، والسقف المقوس، والسقف المقوس الدائري، وسقف القبة الدائرية. للتأكد من النتائج المتحصل عليها في حالة الوصلات المفصلية دون إعتبار الوزن الذاتي تمت مقارنتها بنتائج معلومة. أظهرت المقارنة توافقا جيدا بدقة عالية لا تقل عن 99.66%.

تم الحصول على النتائج من تحليل وتصميم القباب بعد إضافة الوزن الذاتي بإعتبار وصلاتها إما مفصلية أو شبه صلبة أوصلية. وتم تحليل هذه النتائج ومقارنتها بإعتبار صلاحية السقف للغرض العامل الأساس وذلك بهدف دراسة أثر نوع الوصلة على أداء القباب. أوضحت المقارنة أن الوصلات شبه الصلبة تعطي نتائج أفضل من نتائج الوصلات المفصلية أوالوصلات الصلبة.

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List of Symbols

Symbols

N_1, N_2	Shape functions
u	Displacement vector in local coordinates
D_e	Element displacement vector in global coordinates
T	Transformation matrix
L_k, m_k, n_k	Direction cosines
L_e	Effective length
ε	Strain
$[B]$	Strain matrix
$[D], E$	Elasticity matrix
$[k^e]$	Element stiffness matrix in local coordinates
$[K^e]$	Element stiffness matrix in global coordinates
I_x, I_y, I_z	Second moment of area
G	Shear modules
J	Polar moment of inertia of the cross-section
$\{R^e\}$	Element nodal force vector in local coordinates
f_b	Element body force vectors in local coordinates
F^e	Element body force vectors in global coordinates